Effect of Fly ash and RBI Grade 81 on Black Cotton soil as a sub grade for Flexible Pavements

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Abstract- **This paper presents the effects of waste materials like Fly ash and natural soil stabilizer mixed with Black cotton soil at different proportions on Liquid limit, plastic Limit, plasticity Index, Compaction Characteristics, California Bearing Ratio of an expansive soils. The expansive soil was collected locally i.e. from Chikaltana Village –Aurangabad mixed with fly ash from 0 % to 30 % at an increment of 10 %.From the analysis of test results, it was found that Liquid limit, plastic Limit, Plasticity Index, Optimum moisture content, maximum dry density , California bearing ratio increased within increase with the mix of fly ash and RBI Grade 81. From economic analysis it was found that fly ash up to 30 % and 4% RBI Grade 81 utilization can be used in strengthening the sub grade of Black cotton soil in flexible pavements to save the Cost of Construction.**

Keywords – Black Cotton soils, Fly ash, RBI Grade 81, California bearing ratio.

I. INTRODUCTION

Expansive soil are mostly found in the arid and semi arid regions and it cover very large area of the world. It covers nearly 20% of the land in India and includes approximately the entire Deccan Plateau. Maharashtra, Andhra Pradesh, Karnataka and parts of Gujarat and western Madhya Pradesh. Expansive soils are the soils which swell when come in contact with moisture and shrink when it becomes dry. Because of this behavior of soil, lot of damage occur to different Civil engineering structures founded on them .There are sufficient techniques available to improve the engineering properties of expansive soil to make it suitable for construction. Stabilization of expansive soil by using waste material like Fly ash and natural soil stabilizer which have been successfully utilized for stabilization of expansive soil. Because these soil can cause more damage to structures than any other natural hazard including earthquakes and floods.

Black cotton soil is a type of expansive soil with high plasticity and can maintain water throughout the summer season .It exhibit low bearing capacity and high volume change due to presence of clay mineral i.e Montmorillonite. Black cotton soil are formed under condition of poor drainage under alternating rainy and dry seasonal conditions. Black soils usually exhibits high swells- shrink characteristics with surface cracks .These cracks close during wet season such soils are specially problematic when used as sub grade in flexible pavements. The name Black soil cotton soil is derived from the fact that Cotton plant thrives well on it . The black cotton soils of Marathwada region, the color is dark gray to black probably due to Iron and Titanium, compounds present It is classified as CM i.e Medium Compressibility of clays and Silts as per Indian standard classification system has Index properties that shows an inadequacy for most practical engineering use.

II. SYSTEM DEVELOPMENT

Maharashtra is the third largest state in area and population in India. The state is divided into four regions Marathwada, Vidharbha, Kokan and North Maharashtra. Aurangabad district comes under Marathwada region and the total geographical area of the district is 10,107sq km. The district lies between 19 N to 20 N latitude and 74E to 76 E longitude in Deccan plateau zone. The soil are mostly formed from Igneous rocks and are black, medium black , shallow and curious types having different depth and profiles.

The geological formations of this region are characterized by Deccan Traps. The granite rocks have given rise to red as well as black cotton soils. Major parts of this region has deep black soils derived from the Trap rock. Certain variations occur due to exposure and protection. A mixture of Lateritic and Black soil is encountered in the Eastern parts together with Sandy soil along river banks. Most of the hill traps are bare or covered by course gravel while the low lying area accumulates clay loam.

Fly Ash is a waste byproduct from thermal power plants which uses coal as fuel. It is estimated that 170 million tones of fly ash is being produced from different thermal power plants in India consuming 70 thousand acres of precious land for its disposal causing severe health and environmental hazards . In order to utilize fly ash in bulk quantities, ways and means are being explored all over the world. to use it for the construction of embankments and roads. In spite of continuous efforts made by the government hardly 5-10% of the fly ash is being used for construction purpose like brick making, cement manufacturing, soil stabilization an***d*** as filling material. Fly ash is a byproduct from burning pulverized coal in electric power generating plants.

RBI grade 81 is an odorless beige powder that is composed of number of naturally occurring compounds. It works by hydration reaction and it is insoluble in water ,non UV degradable, inert and chemically stable. It improves the structural properties of a wide range of soil, .It is particularly effective with silty clay soil with low geomechanical qualities The pore space is filled by a crystalline growth .Though the addition of low dosages of RBI grade 81 the volume stability of the soil is increased significantly. The reaction with soil particles produces as an inter particle matrix that binds soil particles together into a rigid mass. The binding of the soil particles through both chemical bonds and frictional forces serves the pore volume of created rigid stabilized soil system limit .It forms dust free surface and is simple to apply and hardens fast. It is durable and permanent. It is aesthetical and environmental friendly . Strength of the soil treated with RBI grade 81 increases with age and it converts clay irreversibly into cementatious calcium silicate and aluminum hydrates.

III EXPERIMENTAL ANALYSIS

A. Materials Used

Black cotton soil - A local black cotton soil has collected from Chikaltana village, Aurangabad and used in the present investigation.

The geotechnical properties of Black cotton soil are given below.

1. Specific gravity -2.57
2. Atterberg's Limit
   - i) Liquid limits-43.8 %
   - ii) Plastic limit-26.5 %
   - iii) Plasticity-Index –17.3
3. Compaction Characteristics.
   - i) OMC- 30 %
   - ii) MDD- 1.35gm/ cc
4. Soaked CBR- 2.5%

Fly ash Type C

The geotechnical properties of fly ash used in the experimental program are given below

1) Specific granity-2.72
2) Liquid Limit -30.5%
3) Compaction Characteristics – i) MDD -1.45 g/cc ii) OMC -26%
4) Soaked CBR – 3.65%

RBI Grade 81

Table 1. Physical Properties

Specific Gravity	2.5
Bulk density	700 kg/m cube
Odor	Odorless
PH value	2.5 (Saturated paste)
Solubility	Water 0.25pts per 100 pts
Storage	Dry storage (avoid moisture content)
Shelf life	12 month in case of dry storage

Table 2. Chemical Properties

Calcium Oxide (CaO)	50-60 percent
Silicon dioxide (SiO_2)	15-20
Sodium oxide ($SO_{2)}$	10-15
Aluminium trioxide (Al_2O_3)	5-10
Iron trioxide (Fe_2O_3)	0-2
Magnisium Oxide (Mg O)	0-1
Fibers (Poly propylene)	0-1
Additives	0-4

Testing Process-

Fly Ash has taken from a local supplier M/s J.K.Industries Pvt Ltd MIDC –Chikaltana Auranagabad and having one bag of fly ash weigh 40 kg . RBI Grade 81 one bag weight 20kg was taken from registered supplier i.e M/s Alchemist Ltd –New Delhi . Black cotton soil has taken from Chikaltana Village –Aurangabad for the effect on geotechnical properties when mixed at various proportions.

For conducting different geotechnical tests, the black cotton soil was mixed with fly ash from 0% to 30% at an increment of 10% . RBI grade 81 powder has mixed with Black cotton soil from 0% to 6% at an increment of 2%.The Liquid limit, plastic limit tests, standard proctor compaction tests, UCS test, soaked CBR test were conducted on these samples according to relevant Indian standard (IS) codes.

B. Discussion of Results

Atterberg limits with fly ash

The results of liquid limit test on expansive soil treated with different percentage of fly ash are shown in figure (1)

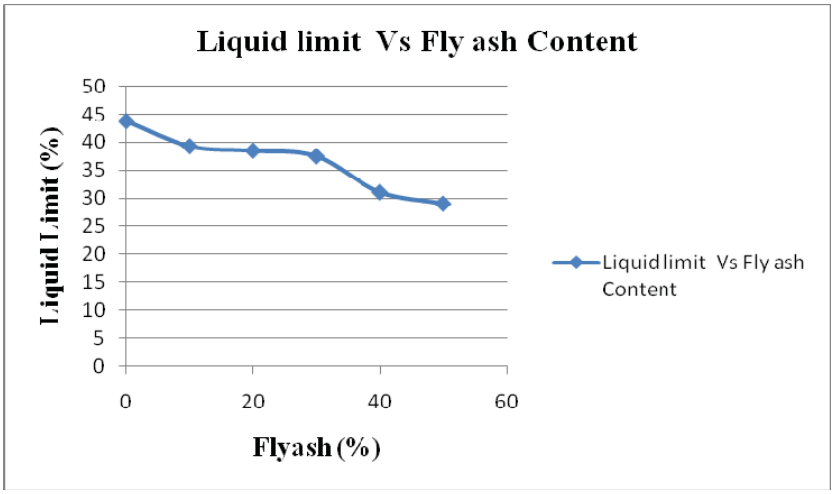


Figure (1) shows the variation of liquid limit of black cotton soil with fly ash .

The result indicates the increase in liquid limit from (43.8%) for the natural soil to a value of value (37.5%) for soil treated with 30% fly ash. The overall decreased in liquid limit could be attribute to the flocculation and aggregation of clay particle accompanying reduction in surface area and increase in strength.

The results of Plastic limit test on expansive soil treated with different percentage of fly ash are shown in figure (2)

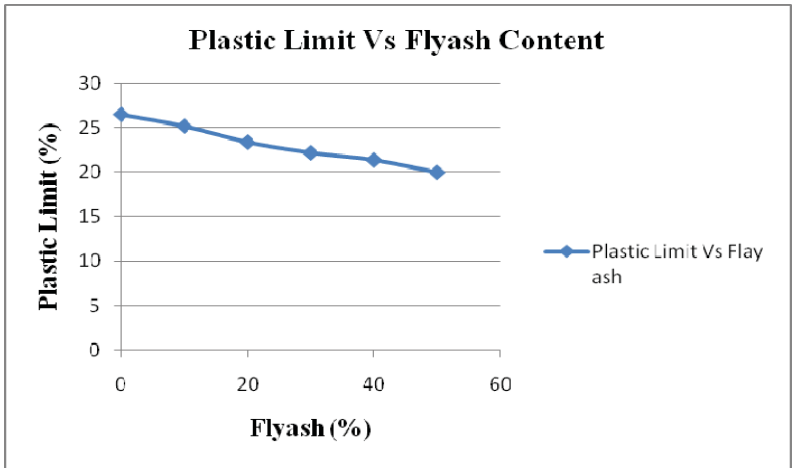


Figure (2) shows the variation of plastic limit of fly ash treated black soil.

There was a decreasing in plastic unit from (26.5%) for the black cotton soil to a value of (22.10%) at 30% fly ash. This alteration of soil characterized probably occurred due to bivalent calcium ions supplied by the fly ash replacing less firmly attached monovalent ions in the double layer surrounding the clay particle. But with higher doses of fly ash, there was a corresponding increase in the plastic limit and this could be due to the increase in the amount of fines content. Consistency limit with RBI grade 81 liquid limit and plastics limit of the black cotton soil mixed with varying percentage of RBI grade 81 are given in below figures.

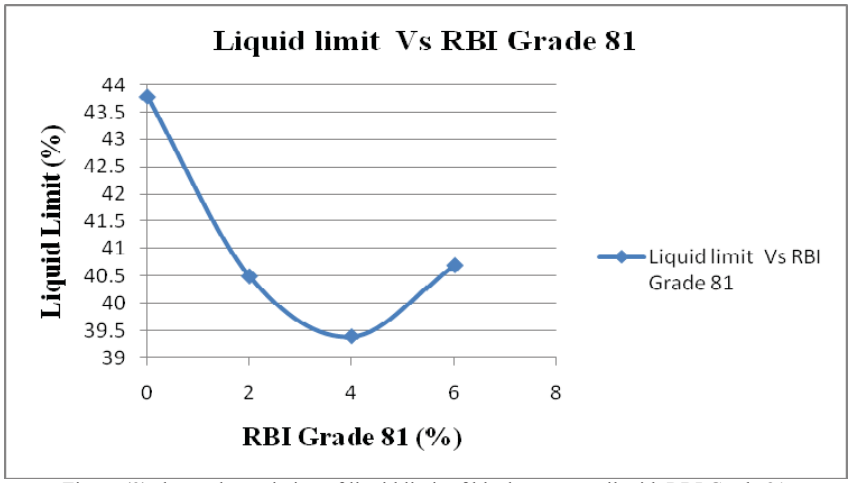


Figure (3) shows the variation of liquid limit of black cotton soil with RBI Grade 81

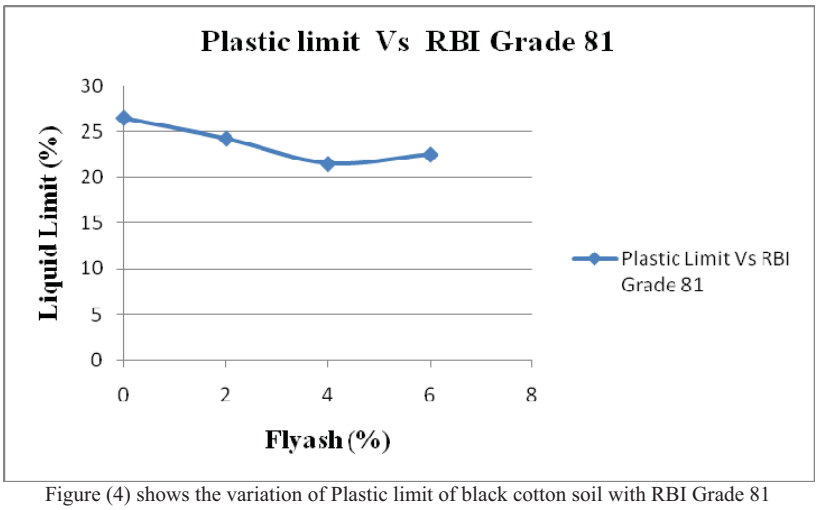


Figure (4) shows the variation of Plastic limit of black cotton soil with RBI Grade 81

Study of Liquid limit and plastic limit under stabilizer given in fig (3 & 4) has improved in plasticity index with 4% RBI Grade 81 due to Chemical reaction between Soil, RBI Grade 81 . Figure shows that the Liquid limit of soil reduces for different proportions of soil.

C. Compaction Characteristics

Initially the MDD of the natural soil was 1.35g / cc . It was observed that as the fly ash content increased, the MDD also increased.

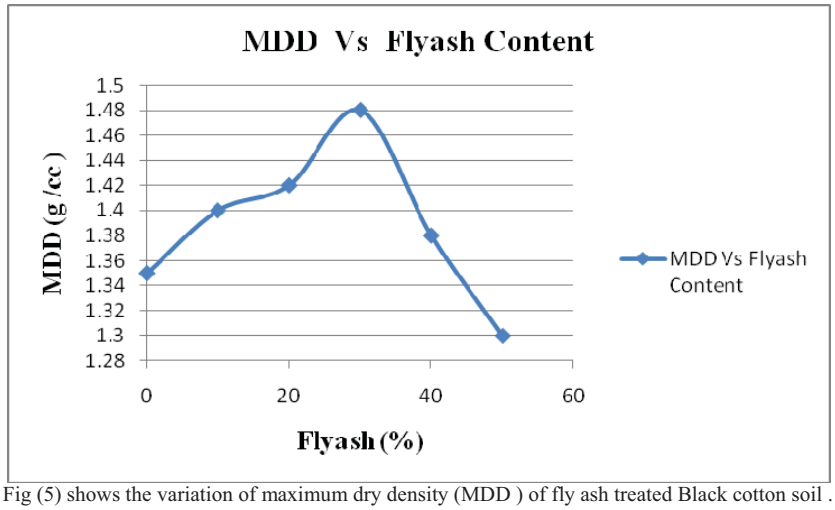
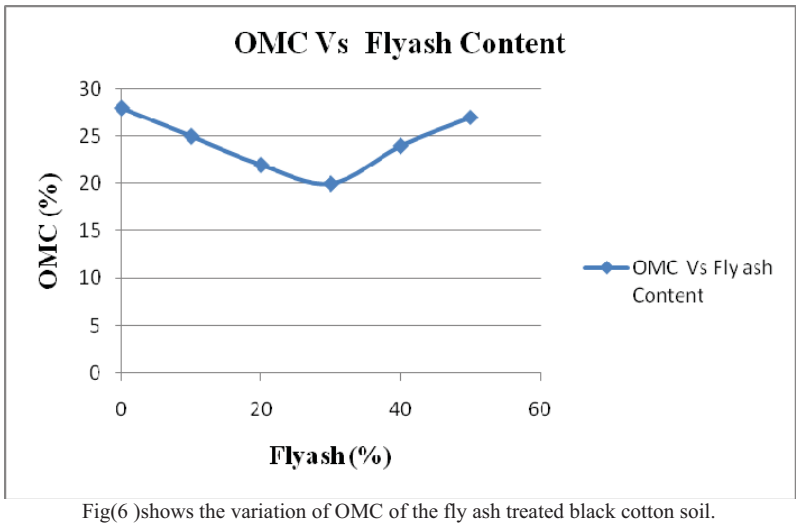


Fig (5) shows the variation of maximum dry density (MDD) of fly ash treated Black cotton soil .

The amount of fly ash increased, the MOD equality increased which may be due to the increased amount of more pozzolanic material in the soil matrix. But after 30% Flay ash content mix the MDD has been decreasing



Fig(6)shows the variation of OMC of the fly ash treated black cotton soil.

The amount of fly ash increased, the OMC has decreased . At 30% fly ash content the OMC was 20%and with further addition of fly ash, the OMC has started increases. The increase in OMC required for pozzolanic reactions to take place.

The effect of RBI Grade 81 on MDD and OMC with different proportions as shown below

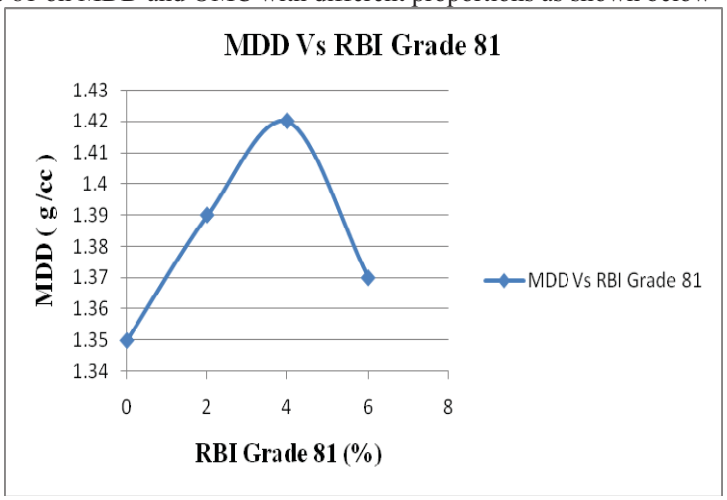


Figure (7) Shows the variation of MDD on Black Cotton soil mixed with RBI Grade 81

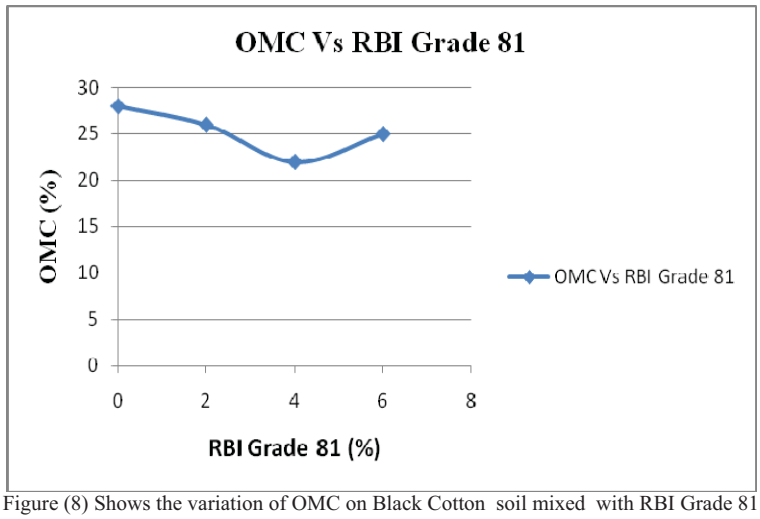


Figure (8) Shows the variation of OMC on Black Cotton soil mixed with RBI Grade 81

Figure (7&8) shows that,there is increase in MDD and OMC of treated soil with RBI Grade 81 at 4% mix than untreated soil. The RBI Grade reacts chemically with soil particles and binds them together and reduces pore spaces and help to increase the MDD of the soil

IV. CONCLUSIONS

A series of laboratory tests were conducted to study the effects of fly ash and RBI grade 81 stabilizer on liquid limit, plastic limit, plasticity index, maximum dry density OMC and soaked CBR of black cotton soil. Based on the findings of the present investigations, the following conclusion can be drawn .

1. The liquid limit, plastic limit, plasticity index goes on decreasing irrespective of the percentage of addition of fly ash.
2. The Liquid limit of RBI Grade 81 mixed Soil decreases with the increasing proportions
3. The addition of 30%flyash change the soil form CM to CH (High compressibility) group as per Indian standard classification
4. It is observed that plastic limit of RBI Grade 81 mixed soil increases with increasing proportions.
5. The MDD goes on increasing and OMC goes on decreasing with increase in percentage of addition of fly ash and RBO Grade 81 at different proportions.
6. The soaked CBR Value has increased from untreated black Cotton soil to treated with fly ash as well as with RBI Grade 81 also. Scope of the work was to propose Chemical stabilization for enhancing engineering properties of Black Cotton soil using RBI Grade 81.
7. From the economic analysis, it is found that fly ash up to 30 %can be utilized for strengthening the sub grade of flexible pavement with a suitable save in cost of construction.
8. The soaked CBR value increase with increase in RBI grade 81 addition suggest its suitability to improve performance of soft soil.

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